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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

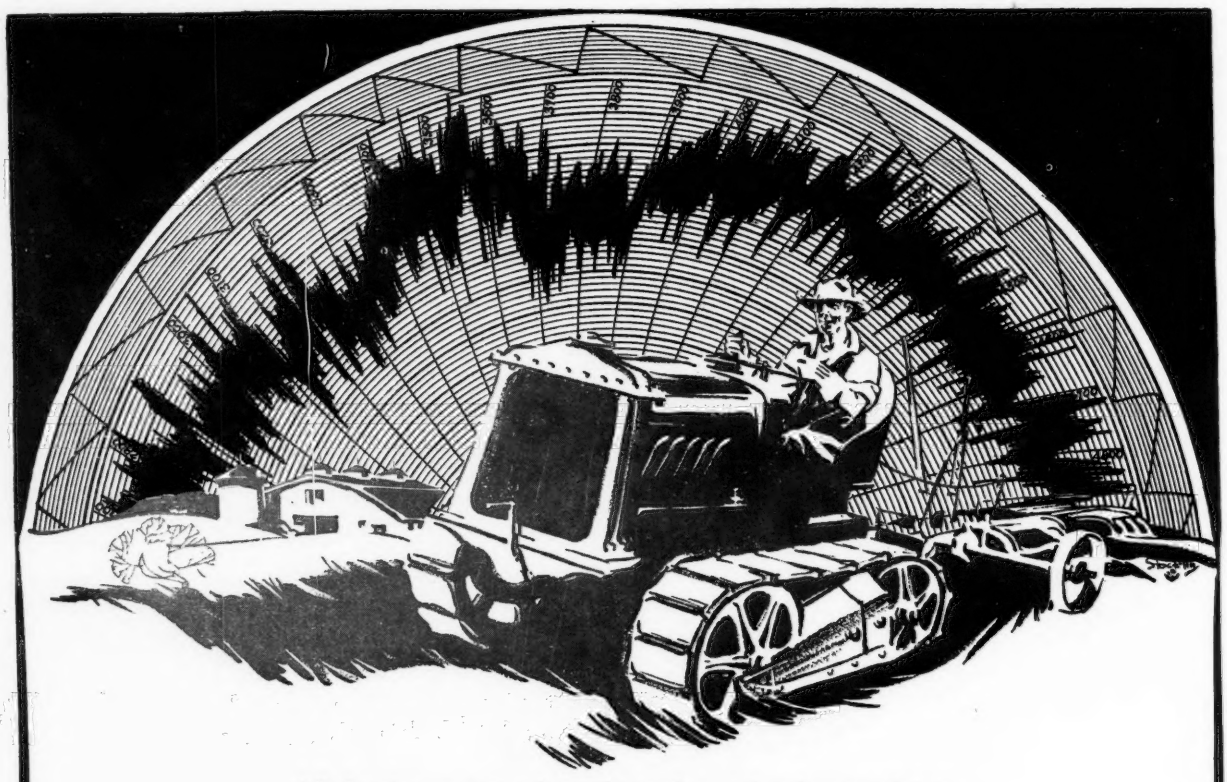
(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.

(b) Farm Structures—buildings and other structures and related equipment.

(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.

(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.

(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.



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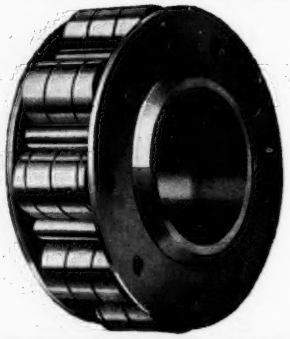


AGRICULTURAL ENGINEERING

Title Registered in the U. S. Patent Office

Vol. 4 AUGUST, 1923 No. 8

A New Dynamometer For Testing Horses

By E. V. Collins

Mem. A.S.A.E. Agricultural Engineering Section, Iowa Agricultural Experiment Station

A NEW type of dynamometer especially adapted for use with horses has been developed at the Iowa Agricultural Experiment Station. This is to be used in a series of tests which have been undertaken by this station to determine the capacity of horses and mules to do work and to determine the effect of some of the factors which may influence the work output of a horse. These factors might be divided into three classes, namely:

1. Working conditions, such as length of day, working speed, load, periods of rest, height of hitch, temperature and ground surface.

2. Care and feeding which would include kind and amount of feed, time of watering, etc.

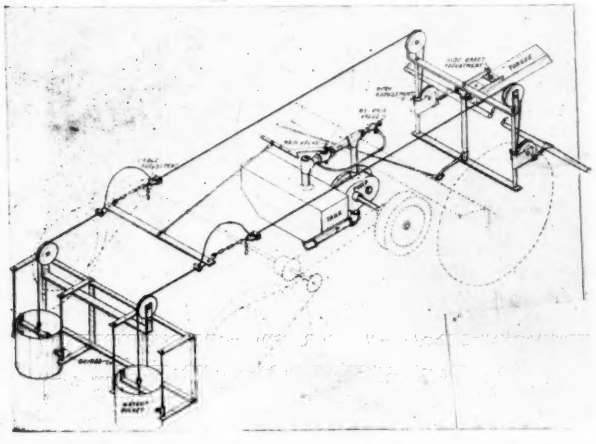
3. Individual characteristics such as breed, unsoundness, conformation, and weight.

The experiment is undertaken cooperatively by four sections of the experiment station, namely: the animal husbandry, veterinary, chemical and agricultural engineering.

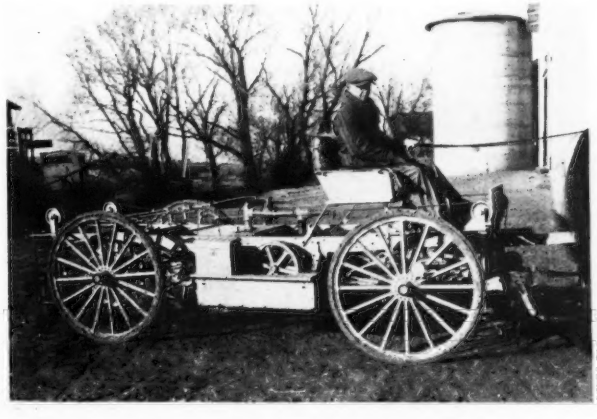
The work of the agricultural engineering section has been largely that of devising and building the equipment to be used in applying loads to the animals. Since draft animals are a very flexible power unit (by this is meant that they can pull a large overload for short periods), it is necessary that any tests be in the nature of endurance tests. The most feasible way to conduct such a test seems to be to increase the working load by a small amount each day until the maximum capacity of the animal is determined for a given distance of travel per day. To do this we must have some means of controlling the resistance which the horse must work against to keep it constant at any desired amount. There are instruments called traction dynamometers which measure the work done in pulling any machine or the work done by tractor or team; however, with this type instrument it is not known what pull is being developed until after the work is done.

An early writer has suggested that the proper estimate of a horse's ability would be that which measures the weight that a horse would draw up out of a well, the animal acting by a horizontal line of traction turned into vertical direction by a simple pulley or roller, whose friction should be reduced as much as possible. This method would have several drawbacks. It could not be continuous. The height of hitch could not be controlled and the road surface could not be changed readily. These objections have been overcome in the new horse testing dynamometer, while the underlying principle is the same, that is, having the horse pull against the resistance caused by a weight attached to a cable which passes over a pulley. In this case the pulley itself moves at the same rate as the horse, its movement being controlled automatically so that the weight is always suspended.

The dynamometer as built provides for testing two horses simultaneously, the load for each horse being independent of the other. The principle of its operation is shown clearly in the skeleton drawing. It was built upon the chassis of an obsolete type of International auto wagon. This was stripped of everything except frame, running boards, jack shaft and wheels. A No. 4 Trahern rotary gear pump was substituted in place of the motor and transmission using the same sprocket that was formerly on the transmission. In this way the pump was driven by the rear wheels when the dynamometer was pulled forward. At 2½ miles per hour the pump makes 184 r. p. m. This pump has a two-inch intake and discharge and circulates oil through a ten-gallon tank. The necessary resistance or breaking effect on the



Skeleton drawing of Iowa horse testing dynamometer



The Iowa horse testing dynamometer ready for a test

dynamometer is secured by restricting the discharge from the pump by means of a valve which is operated automatically by any change in the position of the weights relative to the dynamometer. When the dynamometer is at rest the weights will be at the bottom of the guides. In this position the valve is about 20 degrees past the closed position, or, in other words, it must move 20 degrees before it starts to open. This will prevent rotation of the pump which in turn locks the rear wheels of the dynamometer. Now if we start the team the first action is to raise the weights, since the dynamometer cannot move forward when they are at the bottom of the guides. When the weights have been lifted about one-third of their travel, the valve begins to open permitting the dynamometer to start forward. When starting up it is probable that the weight buckets will strike the top of guides momentarily, but since this opens the valve wide, the dynamometer will move forward easily and the weights will settle back to about mid-position where the valve opening will be such that just the right resistance will be applied to the pump to keep the weights suspended. In this way the regulation of the required resistance is controlled automatically without attention of the operator. It is evident that as long as the weight buckets do not strike either end of the guides that the weight of each bucket represents the force being applied to the single tree of the corresponding horse. It is true that there is a small amount of friction in the sheaves over which the cables pass and in the valve itself, but since they tend to stay in the same relative position with the dynamometer there must be as much friction in one direction as in the other, so the average error due to friction should be zero.

The weight buckets have a vertical travel of sixteen inches. This allows for the change in position necessary to regulate the load as described above and also acts as a sort of equalizer between the horses. It does not equalize the load but permits one horse to pull ahead of the other without affecting the load conditions.

The average height at which the weights are carried will vary some with the load. With the heavier loads more resistance is necessary so the valve must be more nearly closed and in this position the weights will be carried lower. The average position at which the weights are carried may be adjusted by changing the length of lever arm on the valve. This adjustment is necessary only for extreme load conditions. In practice it was found that the weight buckets never touched the ends of the guides except when starting up or when turning short.

With this type of dynamometer the load is under control at all times and the results are easily calculated since it is only necessary to multiply the weight of bucket by the distance traveled to determine the work done. The only calibration necessary is to have accurate weights. The weight buckets are made from sections of 12-inch pipe with a bottom welded in and weigh 60 pounds each. Ten pound weights are made up in the form of segments of a circle so that three of these form a disk which fits inside the buckets. Twenty-four of these may be placed in each bucket bringing the total weight to 300 pounds. On the top of these may be placed ten five-pound lead weights which make the maximum capacity of the dynamometer under the present arrangement 350 pounds per horse. The minimum is the weight of the empty buckets, or sixty pounds each. The machine can be operated by the average teamster having no technical training as there are no delicate parts to get out of order or require adjustment.

The pulleys next to single trees are free to swing sideways and height of hitch is adjusted by raising and lowering these pulleys which are held in place by set collars. This adjustment is independent for each horse. Changing heights of hitch necessitates change in length of cable. This is readily accomplished by means of the short chains which are hooked into the cable line as shown on drawing.

The connection at rear of tongue is adjustable so that wagon can be made either to follow the horses or run to one side in order to simulate any degree of side draft.

A revolution counter is mounted on one of the front wheels and records the distance traveled. A speedometer is so geared to the pump that it gives a reading of ten times the actual speed; that is, when the dynamometer wagon is traveling 2½ miles per hour the speedometer registers 25. It is mounted in sight of the driver and enables him to maintain a uniform speed.

A one-half-inch by-pass valve is provided in the pump circuit to permit the machine being moved slowly by hand or backed. The opening in this valve is so small relative to the volume of oil circulated when in use that it makes no difference whether it is open or closed except on the heavier loads, where it is necessary to have it closed.

Easily accessible containers are provided under the foot board for feces and urine in order that complete digestive tests may be secured.

Preliminary tests were made in the fall to test out the dynamometer and to determine the practicability of the proposed method of procedure in testing. The operation of the machine in governing the load was as near perfect as could be desired, the resistance remaining constant whether the dynamometer was being pulled up hill or down and regardless of road surface. This is true for any condition where the combined resistance applied to the horses is greater than the force necessary to move the dynamometer with the pump valve open.

During the first trials of the dynamometer a great deal of trouble was encountered with surging. The weights would go to the top then the dynamometer would jump forward letting the weights drop and locking the wheels. In order to overcome this action several steps were taken such as providing guides for the weight buckets, placing balance wheels on the pump shaft and trying different types of valves. A steam throttle valve and a valve from a steam engine governor were both tried without success. Finally a common iron cock was used for the control valve and no further trouble was experienced with surging.

It appears to the writer that the same principle might be used in a tractor dynamometer to great advantage, since it would obviate the necessity of delicate and complicated recording devices and the control would be automatic. A similar application would be to use a rotary pump as a Prony brake with a valve so connected that it would be self-balancing. This would be much cheaper than electric dynamometers and would seem to have about all the advantages of the electric instruments at a fraction of the cost and space required.

Come One, Come All!

NOT only every member of the American Society of Agricultural Engineers, but everyone engaged in agricultural-engineering work will find it most profitable, from more than one standpoint, to attend the seventeenth annual meeting of the Society to be held at the Great Northern Hotel, Chicago, November 8, 9, and 10, 1923. The program has been so arranged as to give the various phases of the Society's activities more than the usual time, and this together with some unusually good papers and addresses put the question of attending the meeting on the basis of "Can I afford not to attend it?"

It is not only what one learns or the new ideas he gets from papers and addresses at the annual meeting, but the personal contact with men in similar lines of work and the new inspiration from this contact, that makes an A. S. A. E. meeting worth all and much more than it costs.

Drainage and Supplemental Irrigation for the Willamette Valley in Oregon

By W. L. Powers

Mem. A.S.A.E. Chief in Soils, Oregon Agricultural College

BETWEEN the Coast and Cascade Ranges in Northwestern Oregon lies the great valley of the Willamette River which flows northward to the Columbia River near Portland and has a drainage area of 12,000 square miles. The mean elevation of the floor of this valley is about two hundred feet above sea level, ranging from fifty-seven feet at Portland to four hundred and fifty feet at Eugene. The annual rainfall averages about forty-two inches, being similar to that at Springfield, Missouri, and Indianapolis, Indiana. The rainfall decreases slightly as the floor of the valley is ascended and increases rapidly going up the mountain slopes to the east. The winter rain is more than sufficient to saturate the soils and the run-off is heavy. The growing season is remarkably long, averaging 210 days. The temperature is moderate and uniform. There are mild, moist winters and dry summers, fairly free from extreme heat, the climate being rather coastal in character.

The area of the valley, including national forests, is approximately five million acres. Three million acres of this may be considered as the floor of the valley and the remainder of it foothills. The length of the valley from Oregon City to Cottage Grove is about 120 miles, while in places the width is about 40 miles. Detailed soil surveys have been made of about 60 per cent of the total 5,000,000 acres; these, together with preliminary feasibility, drainage, and irrigation surveys, show that of the 3,000,000 acres in the valley floor and low foot slopes about one-third is wet and will require drainage as a first step in its improvement. About one-sixth of this area, or nearly half a million acres, is regarded as suited to irrigation. This does not include land that has been tiled or needs tiling, but is the more free-working, naturally drained soils along the river and stream bottoms and some naturally drained land in the valley floor that can be reached readily by irrigation water.

Detailed soil surveys show that there are about six soil series represented in the valley, having poor drainage. The soils of the whole area are grouped into (1) the old valley filling soils of the floor of the valley, (2) the recent stream and river bottoms, and (3) the residual hill lands.

The greatest area of wet lands occurs in the old valley filling or the floor of the valley. The leading wet soil series is known technically as the Dayton series and is locally called "white land." Closely related to this is a second series of gray-brown soils belonging to the Amity series, which is frequently designated as "half-white land." It is estimated that there are 100,000 acres of gray soils and 200,000 acres of the gray-brown soils in the valley floor. The gray soils occur in the center of the prairies in the valley and are usually surrounded by the gray-brown land. These gray soils are mainly of silty clay-loam texture and are 10 to 14 inches deep, changing to heavy blue clay subsurface with yellow and brown mottles. At a depth of 33 or 40 inches there is a change again to a clay loam subsoil which is much more pliable. The gray-brown soil has a similar profile but with less of the heavy subsurface or consequent soil stratum, although mottled. The larger prairies of these lands will slope but three feet or so to the mile and will require outlet ditches before drainage can be established.

After some preliminary studies, an experimental drainage system was installed on the experiment station farm of the Oregon Agricultural College at Corvallis in 1914. A main drain of ample capacity was installed at a depth of about 4 feet and a series of laterals 500 feet long was arranged, spaced at different intervals, being 25, 50, 75, and 100 feet apart. Guarded interior laterals of each spacing were brought into the main drain through manholes so that the outflow could be collected and measured. Across the fields between laterals at frequent selected intervals vertical post holes were dug 6 feet deep and were lined with small tile and gravel to make water table observation wells.

In these studies it has been found that the water table is lowered for a distance of about 2 rods away from the tile line within 48 hours after the soil has been saturated by heavy storms. The tile has lowered the water table most promptly when placed just below the impervious layer in the more friable stratum at the top of the deep subsoil. The outflow for the system has run half an inch an acre in 24 hours in wet weather and at times it has reached a maximum of about an inch to the acre in 24 hours. Except for heavy storm periods of four or five days duration, a third of an inch to an acre in 24 hours would be sufficient outlet capacity to handle the percolation.

The laterals spaced 100 feet apart carry water longest but reduce the water table too slowly. The laterals 25 feet apart have drained out the land quicker than necessary and the 50-foot spacing handles the largest amount of water in a given time per thousand feet of tile employed. The yield of crops has been doubled by thorough drainage and it has made it possible to raise clover in a crop rotation. Studies in this field are being continued to determine what treatment will be best to facilitate percolation and render drainage most effective and successful. In these experiments the

TABLE I. DISCHARGE FROM LATERALS PLACED DIFFERENT DISTANCES APART, WINTER 1915-16*

Distance between laterals—feet	Maximum discharge in acre-inches—an acre in 24 hours	Mean discharge in acre-inches—an acre in 24 hours	Mean daily rain previous two days—inches	Daily outflow—per cent	Feet of tile per acre	Mean acre-inches discharge per 1000 feet tile in 24 hours	Yield barley per acre, 1915—bu.
25	1.20	.18	.60	80	1742	.96	33.73
50	1.35	.55	.60	92	872	1.10	29.90
75	.80	.33	.60	55	586	.66	27.90
100	.90	.32	.60	53	436	.64	20.35

*Drainage date from the Department of Soils, Oregon Agricultural Experiment station.

TABLE II, YIELDS FROM DIFFERENT TREATMENTS DRAINAGE FIELD, 1921

Plot	Treatment for Clover Hay	Yield, Tons per acre
1	Untreated	——
2	Lime	2.417
3	Manure	2.715
4	Green manure	2.042
5	Untreated	2.017
6	Lime plus manure	2.731
7	Gypsum plus green manure (gyplate)	2.000
8	Lime plus manure plus green manure	2.900

past season clover at one cutting yielded 2 tons an acre on untreated or check plots. With lime the yield increased to 2.45 tons and with lime and manure, to 2.9 tons an acre. Important data can be found summarized in Tables I and II.

Based on these studies we have come to recommend a drainage co-efficient of one-half inch to the acre up to 40 acres where no surface run would be provided, and a third of an inch to the acre for larger areas. Let the laterals be placed 4 rods apart at a depth of fully 3 feet or down below the impervious subsurface stratum. An experiment was started three years ago wherein one guarded lateral provided with a man hole for measuring the outflow was lined with straw and a second one was lined with gravel. To date the straw has facilitated better the percolation and it was less expensive to provide.

Next to the wet soils of the valley floor the recent stream bottom soils represent our largest wet areas of valley lands. The most extensive types of wet soils here are dark brown soils with mottled subsoils, appearing on the overflow lands along the streams and known technically as Wapato soils. These do not occupy prairies as do the "white land," but all are recognized by farmers as ash swale land. Generally some clearing as well as drainage is required to put them in condition for profitable farming. The largest area of these lands is along the Long Tom River and they constitute what is probably the leading soil type in the Long Tom project, the largest drainage project that will be required in the valley. Rather heavy clearing will be required on part of this soil.

The second important wet soil in the bottom is "black sticky" clay, belonging to the Cove soil series. This soil runs as high as fifty per cent clay and occurs along the edges of the valley where streams from the hills have brought down clay and spread it out in their flood plains. The soil does not respond readily to tiling. The intercepting drain and outlet ditch or tile are highly desirable. There are perhaps two townships or 50,000 acres of this land.

The third wet type occurring in the group of recent alluvial soils belongs to the Whiteson soil series and is a bottom land "white land" similar to the "white land" in the valley floor, but more recent and with less compact subsoil.

The fourth important type, though limited in area, is muck and peat, of which there are perhap 8,000 acres in the valley. About two-thirds of this area has been provided with drainage and where well improved it is used for growing onions, celery, and other intensive crops.

In the upland or hill group of soils which are of residual origin from either sedimentary or igneous rocks, are two important wet series of soils; namely the Carlton and the Irving series. The predominant type of the Carlton series is the Carlton silty clay loam which is a soil of grey-brown color, occurring on the low off-shoots and foot slopes of the hills in the sedimentary section of hill lands, and it has been affected by seepage in places while its subsoil is compact and mottled and interrupts drainage. The surface soil, where rolling, has fairly good natural drainage. Interception foothili ditches to cut off the seepage plus a random or natural system of tiling in the swales is sufficient in this sort of land. Outlets can be secured easily.

The Irving soil series is similar to the Carlton but occurs in the basalt section of the hill land. Its area is limited and treatment required is similar to that of the Carlton soils.

Out of three-quarters of a million acres or more of wet land in the valley floor and low hill slopes, perhaps one-quarter will require community or district outlet ditches. The U.S. Bureau of Public Roads, through its division of agricultural engineering, in cooperation with the soils department of the Oregon agricultural experiment station, has spent several weeks working out preliminary outlet ditch plans for these larger areas in the valley and a preliminary drainage map has been prepared. L. T. Jessup, drainage engineer has developed preliminary estimates for the ditches required and their yardage, and on the average the cost of outlet ditches will not exceed $10 an acre. One purpose of this plan was to point out the wet areas requiring district organization and to show the relation of each drainage unit to another. The drainage of practically all of these wet soils in the Willamette Valley is regarded as feasible and desirable from both engineering and agricultural standpoints, and as fast as the drainage can be provided it is believed that these lands will pay a better rate of interest on the total investment including the drainage. Reclamation will make it possible to use lime on these soils which are acid and to use fertilizer more effectively where they are needed; and it will make it possible to practice rotation of crops including legumes, in order to supply nitrogen to and maintain the humus in the soil. Draining will change these lands from wet pasture lands or lands that are planted to late spring crops with uncertain results, to lands that can be used for general farm crops in rotation, and will double their productive value.

As drought retards growth during the latter part of the dry season or late summer, some interest developed in the possibility of supplemental irrigation in the Willamette Valley. In 1907 the irrigation investigations of the U. S. Department of Agriculture began some irrigation tests at Corvallis and other points to determine the value of irrigation water as a supplement to the limited summer rainfall and to irrigating as a means of increasing production and profits, particularly with the more intensive agriculture that was beginning to take the place of grain growing. Increases in yields of corn, potatoes, mangels, and clover, with gains ranging from 27 to 186 per cent, were secured, indicating that supplementary irrigation wisely used with most late season crops would prove profitable on the naturally-drained, free-working soils of the valley accessible to water.

In 1910 the experiments were extended to include soil moisture investigations and water variation trials, or duty of water experiments, to determine how much irrigation would pay best and to develop practices for securing the highest efficiency and greatest net profit from the pumped water. Water requirement studies were added and also observations of the effects of irrigation upon soil and crops. The soil is representative Willamette silty clay loam, one of the leading soil types in the valley floor. It is rather heavier than some of the bottom lands and less free working than would be ideal for irrigation. From the large variety of crops tested, a stable rotation was arranged, crops being used which responded well to irrigation except the winter grain nurse crop, which is usually unirrigated; and including the rotation of grain, clover, potatoes, followed by manuring and cropping to corn. Against this rotation alfalfa has been grown continuously since 1909. One-quarter acre of each plat has been dry-farmed or cropped under the natural rainfall farming conditions in the valley. The other three-quarters have been given light, medium, and heavy irrigations.

The amount of water that has given the maximum net profit a year as 12-year average, with meadows, ranges from 6 to 12 inches, an average of about 8 inches an acre for the season. The cultivated crops have required from 3 to 6 inches an acre a season. Crops of potatoes have done best where this is applied in two irrigations of moderate amount. The annual cost is calculated at $1 an acre-inch so that $8 total annual investment in water has returned about 2 tons increase in hay; $3 to $5 an acre has returned an average of about 60 bushels more potatoes an acre and 5 bushels an acre more beans. A summary of these studies is given in Tables III and IV.

The water requirement of the crop giving the most net profit an acre, as an average of all seasons, has been 5⅓ inches per ton alfalfa and 3 inches per 100 bushels potatoes.

In the early years of this experiment irrigated legume sod land was plowed and cropped to potatoes, and there was a surprising increase in yield. With irrigation there has been more root growth as well as top growth, and this has resulted in better conditions of available moisture and fertility for each succeeding legume crop. It has also been noticed that with a rank feeding crop, like kale or corn, there is a tendency for the soil to be depleted of its organic material and for irrigation water to cause land to become consolidated.

On account of these things a secondary experiment was planned in 1914 to test the value of rotation, irrigation, and manure as affecting the water requirement, yield and profit from cropped lands. Fourteen plats of gray-brown silty clay-loam soil were employed in this experiment, one-half of which has been irrigated each season, the other half being dry farmed. Two plats were used for beans grown continuously, one without and the other with irrigation; and of the twelve remaining plats, for each season are in grain, four in white beans, and four in clover. The clover follows the grain in the rotation, and the beans have the favored place on the clover sod land. One-half of each crop is irrigated and one side or two of the four plats of each crop is manured, so that there is a dry-farmed plat of each crop in the rotation, a second one that is dry farmed and manured, a third that is irrigated and rotated, and the fourth quarter receives the advantage of irrigation, rotation, and manure.

At the beginning of this experiment the beans yielded about 12 bushels an acre. During the first nine years or three rotations the yield dropped on the continuous crop plat to about 6 bushels an acre and it was increased with irrigation, rotation, and manure to about 22 bushels. The average for continuous cropping has been 9 bushels, and with irrigation, rotation, and manure the yield has been built up so that the average for the period is 18 bushels a year. The water requirement or pounds of soil, rain, and irrigation water required per pound of dry matter produced, with continuous cropping, has been 2909 pounds; with irrigation, rotation, and manure it has been reduced to 1425 pounds, or about one-half. The net profit from rotation and irrigation has averaged $14.90 more than with continuous cropping, and with irrigation, rotation and manure the gain in net profit an acre has been $23.02. Summarized data will be found in Table VI.

With irrigation more than with other types of farming, it is believed important to practice a systematic rotation of crops, including the use of legumes, with the application of barnyard manure, for the purpose of building up and keeping up the water capacity and available fertility of the soil. Large crops are removed and large amounts of fertilizer need to be returned to the land in farm refuse.

As a result of this practice the supply of organic matter in these plats has been increased by one-half to one per cent. By practicing these methods, it appears practicable to save one-third to one-half the irrigation water otherwise needed, and greatly increase the yields and net profits. This is especially important in the irrigation of rather heavy soils in the valley. Irrigation has given higher efficiency where applied just at the right moisture point, or when the soil has dried to the right condition to need it, as indicated by soil moisture tests. The drought point for clover has been proven in the course of these experiments to be more than for potatoes. The best returns have been secured where water was applied when the soil reached the drought point and in sufficient amount to raise the moisture content to the excess point, and to supply usable moisture during the growing season. There is always sufficient moisture in the deep subsoil in these heavy lands, but the surface soil becomes dry in late summer and capillarity is interrupted, and plant food apparently goes out of solution in dry weather. A little supplemental irrigation reestablishes capillary movement, provides moisture for bacterial activity in the liberation of

(Continued on page 134)

TABLE IV. AVERAGE QUANTITY OF WATER GIVING MOST PROFITABLE RETURNS

	Irrigation	Total in. used	Yield in bu.	Water cost
Beets	5.30	11.38	16.556	$ 521.00
Beans	4.00	8.60	22.090	1859.00
Grass	12.60	21.28	4.830	12.60
Alfalfa	7.50	20.64	4.930	793.00
Clover	4.64	19.28	5.290	543.00
Potatoes	3.78	10.12	304.500	519.00

TABLE V. CROP PRODUCING POWER OF WATER*

Alfalfa		Clover		Grass		Beets		Potatoes	
Yield Per A	Acre-in. required	Yield Per A	Acre-in. required	Yield Per A	Acre-in. required	Yield Per A	Acre-in. required	Yield Per A	Acre-in. required
Tons		Tons		Tons		Tons		Bushels	
1	5.23	1	3.84	1	4.27	5	2.5	50	1.5
2	10.46	2	7.68	2	8.54	10	5.0	100	3.0
3	15.69	3	8.54	3	12.81	15	7.5	150	4.5
4	20.92	4	12.81	4	17.08	20	10.0	200	6.0
5	26.15	5	17.08	5	21.35	25	12.5	250	7.5
6	31.38	6	21.35	6	25.62	30	15.0	300	9.0
7	36.61	7	25.62	7	29.80	35	17.5	400	12.0

*Based on an average water cost of most profitable plot records under field conditions, showing least probable amount of water (acre-inches) likely to be needed for different yields.

TABLE VI. VALUE OF ROTATION, IRRIGATION, AND MANURE*

Treatment for Beans	Average Yearly Yield		Average net profit				Water requirement (lbs. per lb. dry matter.)
	Acre	Acre-inch	Acre	Gain from rotation or manure	Acre-inch		
Continuous	9.24	....	$11.55	....	....		2,909
Rotated	10.13	....	20.37	$8.82	....		2,249
Rotated and manured	12.91	....	21.26	9.71	....		1,900
Irrigated continuous	9.85	3.82	15.37	....	$5.12		2,622
Irrigated and rotated	15.74	6.10	29.46	14.09	9.82		1,794
Irrigated, rotated and manured	18.29	7.14	38.39	23.02	12.80		1,425

*Seven-year average reported by the Department of Soils, Oregon Agricultural Experiment Station.

TABLE III. SUMMARY TWELVE YEARS EXPERIMENTS ON VALUE OF IRRIGATION

Crop	No. Years in Trial	Average depth of irrigation—inches	Yield per acre—bushel, or ton		Increase from Irrigation			Dollars per acre-inch	Net profit of whole crop		Lbs. water per lbs. dry matter—whole crop		Gain in net profit-irrigation over dry
			Dry	Irrigation	Per acre	Per acre-inch	Dollars per acre		Dry	Irrigation	Dry	Irrigation	
Potatoes	12	3.69	156.930	215.530	58.590	14.060	24.06	6.58	$72.10	$96.06	738	644	$23.96
Clover	10	6.97	3.910	5.220	1.311	.307	9.26	1.41	30.11	38.05	676	636	7.94
Alfalfa	8	7.96	3.135	4.547	1.412	.225	10.33	1.39	21.20	30.36	961	739	9.16
Corn	8	4.86	6.559	9.062	2.637	.674	2.23	.51	12.18	13.06	794	831	.88
Beans	7	3.66	12.529	17.600	5.356	1.706	12.88	4.04	22.60	34.79	2364	1761	12.19
Beets	8	4.37	10.817	13.884	3.078	1.279	1.49	1.12	9.84	12.22	566	535	2.38
Kale	3	4.33	10.611	13.952	3.273	.692	2.33	.85	1.48	15.32	945	937	10.84

NOTE: The averages are for all comparisons and are not weighted averages. To secure a weighted average the yield of dry plots each season would need to be repeated the same as though there were irrigated plots compared to it for each season.

Agricultural Engineering Digest

Abstract of Current Literature on Engineering as Applied to Agriculture

Edited by **R. W. Trullinger**

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EFFECT OF FIFTY-TON TWO-WHEEL LOAD ON CONCRETE TEST ROAD [*Engineering News Record*, (New York) 89(1922), No. 21, p. 893, figs. 2.] Final tests on the concrete pavement of the Pittsburg, California test road are described, in which a 16-ton load was increased by stages up to 50 tons on two wheels. The maximum load moved over the road three times causing complete destruction of some sections but being carried over others without being delayed by sinking through or breaking up of the surface.

A significant result of the heavy tonnage test was that reinforced sections six inches thick or unreinforced sections eight inches thick were nowhere broken down by the highly concentrated load, nor did they show surface signs of distress anywhere as a result. However, in making core borings, there were many instances where the concrete in the center of the slab was disintegrated.

FLOW OF WATER THROUGH SPIRAL RIVETED STEEL PIPE, F. W. Greve and R. R. Martin [Purdue University, Engineering Experiment Station Bulletin 8(1921), pp. 32, figs. 11.] The data and results of an investigation on the flow of water through 4, 6, 8, and 10-inch galvanized spiral riveted steel pipes are presented in this bulletin. In this work an effort was made to determine the variation of the friction loss with velocity for flow both with and against laps, the variation in accuracy of four types of piezometer rings, and the relation of the friction loss to that in cast-iron pipes for like conditions of diameter and velocity.

It was found that the friction loss in galvanized spiral riveted steel pipes does not differ greatly from that in new smooth cast-iron pipes when the flow is with the laps. It is concluded that spiral pipe should be laid so that the flow is with the laps.

It is further concluded that the friction loss may be expressed as $h_1 = m\ (v)^n$, where h_1 is the loss due to friction expressed as head in feet of water, v is the true mean velocity in feet per second, and m and n are constants for any given diameter of pipe. The relations of m and n to diameter are readily established, allowing the probable friction loss to be calculated for any size of spiral pipe when experimental data are not available. Sample computations and tables of working data are appended.

TESTS OF DRAINAGE PUMPING PLANTS IN THE SOUTHERN STATES, W. B. Gregory [U. S. Department Agricultural Bulletin 1067(1922), pp. 54, pls. 2, figs. 9.] This bulletin contains a short description of the various types of drainage pumping plants found in the southern coast country, and gives the results of tests thereof that have been made since 1909 by the division of agricultural engineering of the U. S. Bureau of Public Roads. The different types include drainage wheel, chamber wheel, centrifugal, and screw pumps, using steam and internal-combustion engines and electricity as power. The tests are given in detail, together with data on the cost of operation of plants. It is shown that the cost decreases as the size of the project increases. The average cost per acre of operating a pumping plant for a project of 3,000 acres is approximately $1 per acre per year more than for a project of 7,000 acres. The most expensive plants for projects containing 2,400 acres or more are the steam plants with slide-valve engines. There is little choice between the simple Corliss engine and the compound condensing type, the former having a slight advantage for projects of more than 5,000 acres and the latter being a little cheaper for projects of from 2,000 to 5,000 acres. The cheapest plant of all operates by internal-combustion engines and the difference in various plants depends quite largely on the cost of fuel.

HYDRAULIC DIAGRAMS FOR THE DISCHARGE OF CONDUITS AND CANALS, T. Horton and C. H. Swan [New York and London; McGraw-Hill Book Company, Inc., 1922, 3. ed., rev. and enl., pp. 53, figs. 19.] This is the third revised and enlarged edition of this work. It presents a set of diagrams based on the formula of Ganguillet and Kutter, and is intended for use in the study of such sections of conduits and canals as are commonly employed in sewerage, water supply, water power, and land drainage. The set includes conduits of ten different types of cross section and canals of rectangular and trapezoidal cross section. The Ganguillet and Kutter formula is discussed and the use of the diagrams explained.

STUDIES ON FRICTIONAL LOSSES IN INTERNAL-COMBUSTION MOTORS, A. Planiol [Comptes Rendus Academie Sciences (Paris), 174(1922), No. 13, pp. 860-863.] A series of experiments extending over two years with a single cylinder, four-stroke cycle, 30 horsepower internal-combustion engine, operating on illuminating gas, is reported, the purpose of which was to determine the relation between friction losses and mean pressure. An equation of the form $C_f = a + b\pi$, in which C_f is the friction and π the mean pressure, was found to express the relation correctly for the experimental motor to within one-half of one per cent when the constants a and b have values of 16 and 4.5, respectively.

Further experiments to determine the modifications of this formula necessary to make it applicable to other motors of different horsepower are also described. The above formula was modified to the form $C_f = C\ (a + b\pi)$, in which C is the maximum couple. Thus for the experimental motor this equation resolved itself into $C_f = 140\ (0.114 + 0.032\pi.)$ On this basis the values actually found for a and b for a 35 horsepower motor were 0.115 and 0.038, respectively. It is thought that this method may simplify the calculation of the efficiency of an internal-combustion motor.

COEFFICIENTS OF DISCHARGE FOR SUPPRESSED SUBMERGED ORIFICES, J. Hinds [Reclamation Record (U. S.), 13(1922), No. 10, pp. 253-255, fig. 1.] The results of experiments upon six sizes of suppressed submerged orifice are presented in tabular form and discussed, and a typical diagram for a 1-by-4 foot orifice is given. The discharge coefficient varied from 0.61 for a 0.5-by-2 foot orifice to 0.645 for a 1-by-2 foot orifice.

A PRELIMINARY STUDY OF THE PROBLEM OF FREEZING IN THE SEPTIC TANK SYSTEM OF SEWAGE DIS-

POSAL, R. R. Graham [Scientific Agriculture, Gardenvale, Prov. Quebec, Canada, 3(1922), No. 2, pp. 65-68, figs. 5.] Studies conducted at the Ontario Agricultural College on the problem of freezing in septic tanks and in final disposal systems are reported.

Bi-record thermometers were installed, one over an experimental septic tank and the other over an absorption bed. One bulb of the latter thermometer was placed down into the tile of the absorption bed two feet below the surface and the other bulb three feet above the ground to record the air temperature. Three ordinary soil thermometers were inserted in the soil over the absorption bed, one directly over the tile but only one foot deep and the other two midway between two rows of the tile, one two feet deep and the other one foot deep.

The results of the readings showed that the temperature of the soil at one foot depth over the tile was about two degrees higher than that of the soil at the same depth midway between two rows of tile and about two feet away. The temperature in the tile was 5 per cent or more higher than that of the soil at the same depth midway between the rows of tile.

The average air temperature for the three months of the study was approximately 20 degrees Fahrenheit, the average temperature in the tile about 40 degrees, in the receiving chamber about 53 degrees, and in the flushing chamber 44 degrees. For the whole period there was a range of 52 degrees in the air temperature, 10 degrees in the tile, 27 degrees in the receiving chamber, and 22 degrees in the flushing chamber. The lowest temperature in the air was—6 degrees, in the tile 34 degrees, in the first chamber 44 degrees, and in the second chamber 34 degrees. The effect of the heat generated by the bacteria in the first chamber was very pronounced, and it is noted that the temperature in the tile was very similar to that in the second chamber.

This is taken to indicate that if tanks are kept well covered the temperature in the tile may be controlled to a large degree. It is also thought that if the absorption bed is covered with from six to eight inches of straw, the temperature in the tile may be maintained at a safe point even in the coldest weather. The studies are being continued.

SWEET POTATO STORAGE IN TEXAS, E. A. Miller, M. R. Bentley, and J. J. Taubenhaus [Texas Agricultural College Extension [Bulletin 1 College Station B-60(1922), pp. 32, figs. 22.] This bulletin gives practical information on the harvesting, grading, and storing of sweet potatoes in Texas and describes, diagrammatically illustrates, and gives bills of materials for special types of storage house developed for Texas conditions.

COMBINED IRRIGATION AND DRAINAGE PLANT IN LOUISIANA, A. M. Shaw [*Engineering News-Record*, New York, 89(1922), No. 18, pp. 741-744, figs. 3.] A system of combined drainage and irrigation in use in Louisiana on rice soils is described and the important feature illustrated. In this system the pumping plant, consisting of one oil-engine pump, delivers or removes water as needed on the rice plantation. Two ditch systems with control gates are used.

THE DESIGN OF MASONRY STRUCTURES AND FOUNDATIONS, C. C. Williams [New York and London; McGraw-Hill Book Company, Inc., 1922, pp. VIII—555, pls. 2, figs. 266.] This is a textbook on the subject which is intended to cover the fundamental principles rather than to describe typical examples. An attempt has been made in every case to offer a mode of analyzing forces and calculating resulting stresses and to indicate an acceptable method of design. Chapters are included on general principles, masonry laid in mortar, plain concrete, reinforced concrete, masonry arches, dams and sea walls, retaining walls and quay walls, bridge abutments and piers, concrete viaducts and trestles, culverts and underground conduits, bins and chimneys, masonry forms and falsework, foundations on dry ground, open foundations under water, and foundations under water—pneumatic process.

PHYSICAL PROPERTIES OF SUBGRADE MATERIALS, J. R. Boyd [American Society Testing Materials Proceedings, 23(1922), pt. 2, pp. 337-355, figs. 15.] This is a report of further studies by the U. S. Department Agricultural Bureau of Public Roads on tests for determining the physical properties of road subgrade materials (E. S. R., 45, p. 587).

The results indicate that there appears to be at least three important factors upon which the physical properties of subgrade soils depend, namely, the graduation, which is expressed by the mechanical ratio, the moisture content, which is expressed by the moisture index, and the character of the soil, which is expressed by the absorption number. When the clay content of the soil is increased, its ability to take up and retain moisture and its percentage volume change have been found to be increased. The character of the soil influences its percentage volume change, as is evidenced by the fact that for increasing absorption numbers the percentage volume change increases. When the moisture index of the soil is less than unity, the bearing value will be high, and when it is above unity high bearing values can be obtained, provided the absorption of the soil is high.

DIAGRAM FOR DESIGNING OPEN DITCHES WITH 1:1 SIDE SLOPES, F. T. Mewes [Engineering News-Record, New York, 90(1923), No. 4, pp. 173, fig 1.] Graphic data are presented on the velocity of flow and discharge of open ditches, which include a logarithmic diagram to determine the hydraulic radius and cross-sectional area of ditch for a given bottom width and depth of flow, and a nomographic diagram to determine the velocity of flow for a given hydraulic radius, hydraulic slope, and roughness coefficient n. The latter diagram is based on Manning's formula for velocity, in which the roughness coefficient n is equal to Kutter's n. The diagram is arranged for a value of n of 0.035.

COMPARATIVE TESTS OF ROOF VENTILATORS, F. B. Rowley [*Journal American Society Heating and Ventilating Engineering*, New York, 29(1923), No. 1, pp. 9-13, figs. 13.] Tests of five distinct types of roof ventilator, conducted at the University of Minnesota, are reported together with a description of the method and apparatus used. The ventilators were all 10 inches in diameter. The wind velocity was produced by a fan discharging through a 36-inch circular duct. The ventilators were placed 3 feet 10 inches in front of the outlet and in such a position that the center line of the head was as near as possible in the center line of the duct.

The best results were obtained by a so-called rotary siphoning type of ventilator, closely followed by a so-called plane stationary type. It is thought to be impossible to expect uniform results from ventilators of the same class, but that ventilators even though similar will give entirely different results, depending upon the dimensions and proportions.

AN IMPACT TEST FOR GRAVEL, F. H. Jackson [American Society Testing Materials Proceedings, 22(1922), pt. 2, pp. 362-367, figs. 2.] In a contribution from the U. S. Division Agricultural Bureau of Public Roads an impact test for gravel is described. The apparatus used consists essentially of two 2.5 inch steel balls, the lower ball fastened rigidly to a cast-iron anvil measuring 5 inches in diameter by 1.75 inches high and the upper one free to fall between three

⅜-inch guide rods. An adjustable stop, provided with a clamping nut, slides on one of the guide rods. Fastened rigidly to the upper ball is a ⅜-inch rod graduated in inches, which passes through a hole in the stop. The hammer, consisting of the upper ball and the graduated rod, weighs exactly 1,200 grams while the remainder of the apparatus weighs exactly 6 kilogrammes, so that the ratio of the weight of the hammer to the weight of the anvil is 1:5.

The fragment to be tested is held firmly on the lower ball so that its smallest diameter is vertical. The upper ball is then allowed to rest on the test specimen and the stop is adjusted and clamped at the height of the fall desired, measured in inches directly on the rod. The upper ball is then raised until it comes into contact with the stop and allowed to fall upon the specimen until a height is reached at which fracture occurs.

Tests of the apparatus on different samples of gravel seem to indicate that for a material of uniform quality a fairly definite relation exists between the height of fall and the diameter of the particle.

THE BASIS OF EGYPTIAN AGRICULTURE AND ITS RELATION TO THE DECLINE IN THE AVERAGE YIELD PER FEDDAN OF COTTON, E. M. Taylor and A. C. Burns [Egypt Ministry Agricultural Technical and Scientific Service Bulletin, 25(1922), pp. VI—70, pls. 5.] Studies of the history of the development of perennial irrigation and the modifications it has induced in Egyptian agriculture are reported, which included an extensive biological study of Egyptian soils.

The conclusion is drawn that the basis of Egyptian agriculture under the basin system of irrigation was the sharaqi period, or period of compulsory fallow. The authors attribute the maintenance of the fertility of the soil to this fallow. The development of perennial irrigation has resulted in a change of the basis of Egyptian agriculture from sharaqi to its antithesis, a maximum summer water supply. It is emphasized that the development of perennial irrigation has created a new and not intensified an old system of agriculture.

The results of soil studies led to the conclusion that the fertilizing properties of Nile silt have been considerably exaggerated. This conclusion is supported by the similarity in composition of Nile silt and of the soil, the proved absence of readily nitrifiable matter, and the lack of response of the cotton crop to fertilizers in general. It appears, therefore, that the deposition of Nile silt upon the land was probably not the main factor concerned in the maintenance of the fertility of Egyptian soils. The sharaqi period was typical of the system of agriculture in the large cotton-producing provinces under perennial irrigation until 1898. Since that date sharaqi has no longer been typical of the agricultural practice of certain localities, which coincides with the beginning of the period of decreasing yield.

It was demonstrated in the laboratory that the heating of the soil to a temperature attained during the sharaqi period increased the subsequent production of nitrate, resulting in an increased crop, as evidenced by pot experiments. The biological studies showed that nitrifying bacteria capable of withstanding a temperature of 58 degrees Centigrade exists in Egyptian soils, hence there is no check to nitrification after partial sterilization.

The fact that protozoa are introduced into the soil by irrigation and that suitable conditions for their development are induced in poorly drained soils is taken to indicate that the protozoa are the limiting factor in crop production. The analogy between "sewage sickness" and the soil conditions in certain Egyptian localities led the authors to define the condition of the soil resulting from perennial irrigation as "irrigation sickness."

It is shown that the decline in yield of cotton can be directly attributed to the factor limiting the bacterial activity and the formation of the optimum soil solution. The intensification of the sharaqi effect by means of plowing during the summer period is suggested as a means of suppressing completely the protozoa in the soil and restoring its crop producing power.

A bibliography is appended.

PRELIMINARY IMPACT STUDIES—SKUNK RIVER BRIDGE ON THE LINCOLN HIGHWAY NEAR AMES, IOWA, A. H. Fuller [Iowa Engineering Experiment Station Bulletin, 63(1922), pp. 31, figs. 8.] This is a report of preliminary studies conducted under a cooperative agreement between the U. S. Department of Agriculture, the Iowa State Highway Commission, and the engineering experiment station of Iowa State College, the object of which was primarily to investigate the effect of impact of trucks and tractors upon a 150-foot span, 20-foot roadway, through riveted steel highway bridge with a 6-inch concrete floor on steel stringers. The preliminary work comprised studies of the distribution of stress throughout various members and portions of members, and the comparison of a number of different instruments to determine which ones would be the most suitable for future work. Two trucks and a "caterpillar" tractor were used as loads.

The results of about two hundred observations condensed from 2,500 field observations are presented in this report. Owing to its preliminary nature no definite conclusions are drawn.

RECLAMATION OF USED PETROLEUM LUBRICATING OILS, W. H. Herschel and A. H. Anderson, [U. S. Department Commercial Bureau Standards Technology Paper 223(1922), pp. 93-108.] This publication discusses the reclamation of lubricating oils, particularly those used in the lubrication of internal-combustion motors, and describes different methods at present available for such reclamation. Tests of certain methods are described.

The conclusion is reached that used oils should be judged by the same tests as are applied to new oils, and that the present methods of reclaiming oils are successful in so far as the generally recognized tests are concerned. Improvements are said to be limited by a lack of knowledge concerning what additional tests are needed to make sure that oils, whether new or reclaimed, possess those properties which make them suitable when new and durable in use. Further investigation is said to be needed especially concerning the value of the tests for acidity, sulphur, and resistance to oxidation.

PROTECTIVE METALLIC COATINGS FOR THE RUST-PROOFING OF IRON AND STEEL, [U. S. Department Commercial Bureau Standards Circular 80(1922), 2. ed., pages 34, pls. 12, figs. 5.] This publication discusses the nature of corrosion of iron and steel and the principles underlying methods of prevention of corrosion. Types of coatings and methods of application are described, microstructure is discussed, and information is given on the preparation of the surface before coating and the accompanying effects upon the mechanical properties of the steel. Methods of testing coatings are also described.

It is recommended that zinc coatings be given preference over all others when the object of the coating is protection against corrosion only. For general use on large, smooth surfaces, sheets, rods, wires, pipes, etc., the hot-dipped zinc coatings are entirely satisfactory, although some of the other processes are more economical in the amount of zinc used. Too heavy coatings of the hot-dipped type should not be used on articles which must be sharply bent or shaped on account of the tendency of the coating to flake off at such

points. One ounce of zinc per square foot of surface exposed is considered to be satisfactory for most purposes, but less may be sufficient if evenly distributed.

The hot-dipped and sherardized zinc coatings are not recommended for hardened and tempered steels. The plated zinc and the sherardized coatings are both recommended for accurately machined parts, and so-called spray coatings are considered to be valuable for large or complex parts which must be coated in place or after assembling.

Nothing is said to be gained from the standpoint of resistance to corrosion by first coating an article with copper or a similar metal and then finishing with zinc. Black nickel may be used to provide a black finish for a zinc coating. The use of oil and like substances on any type of coating is recommended strongly. It is stated that the life of zinc coatings, particularly those of a porous nature, may be prolonged almost indefinitely by periodic oiling.

The time required for the appearance of rust on zinc-coated articles when exposed to salt spray may in general be taken as an indication of whether or not the coating is satisfactory for outdoor exposure. A period of twenty-four hours is considered to be unsatisfactory, from forty-eight to seventy-two hours satisfactory for mild exposure, and from ninety-six to one hundred and forty-four hours satisfactory for severe exposure.

CAUSTIC MAGNESIA CEMENT, [U. S. Department Commerce Bureau Standards Circulation 135(1922), pp. 14.] A brief summary is given of the discovery, early history, and later application of the reaction of caustic magnesia with solutions of magnesium chlorid, resulting in the production of a quick-hardening cement. Short descriptions are given of the ore used and of methods of calcining the ore. Formulas are also suggested for several types of products, together with information on the development of specifications.

VENTILATION OF RURAL BUILDINGS, M. Lallie [*Vie Agr. et Rurale*, 11(1922), No. 48, pp. 406-410, figs. 8.] Four French types of aspirator for use as an accessory part of the ventilating system for farm outbuildings are described and diagrammatically illustrated, and tabular data covering the range of their utility are presented. These represent two distinct types of aspirator, one in which the current of air or wind enters and leaves horizontally, producing a suction influence on the air in the ventilator, and the other in which the wind current enters at an angle and eventually becomes parallel with the movement of the column of foul air in the ventilator.

THE PRESENT STATUS OF MECHANICAL SOIL TILLAGE IN JAVA, C. E. van der Zyl. [Archief voor de Suikerindustrie in Nederlandsch-Indie, 1922. No. 4, pp. 155-193, figs. 6]. This is a rather detailed summary of the results of different experiments on the mechanical tillage of rice and sugar-cane soils in Java which have been considered, particularly tractor and cable-drawn plows, plowing versus trenching, and the relation between the period of planting and soil cultivation.

It has been found that in trenching mechanical tillage saves time, but no time is saved in straight plowing since the soil must be allowed to dry for about eight days before it can be harrowed and finally prepared for planting. Trenching has been found to be preferable to plowing in heavy soils, although a great drawback of trenching in wet soils with tractors is the slipping of the "caterpillar." For this reason cable outfits have given better results than tractors.

It is generally concluded that motor cable outfits and trenching machines give the best results in the tillage of Java sugar-cane soils.

THE EFFICIENCY OF LOW TEMPERATURE COKE IN DOMESTIC APPLIANCES, M. W. Fishenden. [Great Britain Department of Science and Industrial Research, Fuel Research Board, Technical Paper 3 (1921), pp. 35, figs. 10]. A brief account is given of a series of experiments made to compare the efficiencies of coke made by a low temperature carbonization process and ordinary bituminous coal in various domestic room heating and water heating appliances. The studies included experimental determinations of the radiation from open sitting room and kitchen grates, determinations of the water heating produced in various types of boiler for domestic hot water supply, and approximate oven tests. The coal used was a soft caking bituminous coal having a calorific value of 14,700 B. t. u. per pound. Four cokes were used varying in calorific value from 11,900 to 12,900 B. t. u. per pound.

It was found that in each of three open sitting room grates of different design coke gave a considerably higher radiation efficiency than coal. The advantage of the coke over the coal in this respect was more pronounced the higher the efficiency of the grate. In all cases the coke lighted easily and produced a bright, smokeless, and very hot fire.

Similar results were obtained with kitchen ranges and water heating devices. The conclusion is drawn that for such uses the calorific value of a bituminous coal in all cases must be considerably greater than that of low temperature carbonization fuel if it is to give equal results weight for weight

The coke was found to compare somewhat less favorably with coal for oven heating, and approximately equal numbers of heat units were required to give similar results. The advantage of the coke in this case appeared to be largely due to radiation effects and was most marked when the distance between the fuel bed and the oven was low. This advantage decreased as the distance increased until a point was reached in some cases where the coal gave better results owing to its flame contact.

Tests of the efficiencies of kitchen ranges indicated the magnitude of the reduction in radiation efficiency which the presence of a boiler behind an open fire entails, the mean value for radiation being the equivalent of from 8 to 12 per cent of the heat units of the fuel burned. A large old-fashioned open kitchen range with an oven at one side, a hot plate at the other side, and an iron saddleback boiler behind the fire gave about 17 per cent of the heat of the coal consumed in hot water, run off at temperatures suitable for household purposes, under the most favorable conditions. The radiation amounted to about 10 per cent. Very similar results were yielded by several more modern designs of range, practical water heating at its best varying from about 13 to 19 per cent and radiation to 10 or 11 per cent. For water heating none of the ranges examined, whether modern or old-fashioned, approached the performance of an independent boiler. The example of the latter class, which was selected for test, gave a water heating efficiency of more than 30 per cent for coal and more than 40 per cent for coke cakes (or, if corrected for heat losses from the cylinder and pipes, about 36 and 46 per cent, respectively), and in addition the open fire radiation accounted for a further 7 or 8 per cent.

THE NET DUTY OF WATER IN SEVIER VALLEY, O. W. Israelsen and L. M. Winsor. [Utah Station Bulletin 182 (1922), pp. 3-36, figs. 5]. The results of seven years of experiments on the net duty of water for staple crops on typical soils in the Sevier River Valley in Utah are reported in this bulletin. The experimental soils are classed as Bingham gravelly sandy loam and Redfield fine sandy loam.

Apparent specific gravity tests of the soil in its natural state showed its average weight to a depth of 6 feet when oven dry to be 83 pounds per cubic foot. Also, nearly 52 per cent of the soil volume is pore space. The average permeability of the soil is 0.7 inch depth of water an hour, that is, free water standing on the surface of the soil will disappear at the rate of 0.7 inch an hour.

Determination of the maximum capacity of the soil to absorb and retain water showed that one day after irrigation it held nearly 1.5 inch and twenty days later less than one inch to the foot of soil in excess of the amount held before irrigation, notwithstanding the fact that evaporation had been prevented. It is, therefore, considered likely that one inch of water for each foot of soil that needs moistening is ample in a single irrigation, provided it is spread uniformly over the surface.

The crops used were sugar beets, potatoes, and alfalfa. During the greater part of the time the beet and potato plats were run in triplicate and the alfalfa plats in duplicate.

The results indicated that the application of from 27 to 33 inches of water in four or five irrigations to sugar beets, and retained on the farm, of from 21 to 27 inches to potatoes, and of from 30 to 36 inches uniformly distributed on alfalfa, will give economical returns on these soils.

The amounts of water for the three crops above suggested include the early irrigation before seeding but do not include the water lost from the farm through surface run-off. Measurements of surface run-off indicated that large percentages of water are lost in spite of careful preparation of land for irrigation. The amount of water applied in a single irrigation seemed to be the most important single factor in the control of run-off, the loss for sugar beets and potatoes varying from nine per cent with 2-inch irrigations to 28 per cent with 8-inch applications. The run-off measurements for alfalfa were smaller than for sugar beets and potatoes.

THE PRESSURES DEVELOPED IN GASEOUS EXPLOSIONS, W. T. David. [Engineering (London), 114 (1922), No. 2974, pp. 791, 792, figs. 7] A series of pressure curves prepared from records made with an optical indicator with a high frequency spring, indicating the pressures developed in a cylindrical cast-iron explosion chamber with flat ends by the explosion of coal gas, are presented and discussed.

With a mixture of 15 per cent of gas and 85 per cent of air it was found that when the spark was placed in the center of the vessel, the time of explosion was less and the maximum pressure developed was greater than in the case where the spark was placed near one end of the vessel. In the former case the time of explosion was 0.05 second and the maximum pressure 105 pounds per square inch above atmospheric, and in the latter case the time of the explosion was 0.075 second and the maximum pressure 100 pounds per square inch above atmospheric. The greatest maximum pressure was clearly developed when the spark was placed in the center of the vessel.

In studies of the effect of strength of the gaseous mixture it was found that with a 15 per cent mixture a maximum pressure of 105 pounds per square inch was developed in 0.05 second; with a 12.5 per cent mixture a maximum pressure of 90 pounds per square inch was developed in 0.075 second, and with a 10 per cent mixture a maximum pressure of 76 pounds per square inch was developd in 0.14 second. The 15 per cent mixture required practically the whole of the oxygen in the air for its complete combustion. The weakest mixture of this coal gas which would ignite on passage of the spark contained between 7 and 8 per cent of coal gas.

Studies of the effect of density of mixture showed that the time of explosion increased slightly with the density of the mixture. Also the ratio of the maximum absolute pressure to the initial pressure increased slightly with the density.

Studies on the effect of the nature of the interior surface of the explosion chamber on pressures developed showed that the maximum pressure was about three per cent greater and the rate of cooling much slower where the interior surface was polished than where it was blackened. The presence of inert carbon dioxid was found to reduce greatly the maximum pressure developed and to slow down the speed of combustion.

UTILIZATION OF ELECTRICITY AND COAL FOR THRESHING, Taegen [Fuhling's Landwirtschaften Zeitung, 71 (1922), No. 11-12, pp. 226-232] The results of a test made in December, 1921, to compare the costs of threshing by electric motor and steam tractor are reported briefly. The thresher used was equipped with self-feeder and straw press and had a threshing cylinder 1,680 by 620 millimetres (about 66 by 25 in.). A 40-horsepower motor of recent manufacture was compared with a thirteen-year-old 22 horsepower steam tractor using soft coal for fuel. The electric motor threshed an average of 8,360 pounds of rye grain with an energy consumption of 0.452 kilowatt hour, while the steam tractor required 2.38 pounds of coal to thresh 220 pounds of rye grain. Considering costs of lubricating oil, attendance, depreciation, interest, etc., the cost of threshing by electricity in this test was about twice as great as that of threshing by steam tractor.

AIR FILTERS FOR MOTOR-DRIVEN AGRICULTURAL MACHINES, Meldau [Technical Landwirtschaften, 3 (1922), No. 12, pp. 294-297, figs. 23] Different types of air cleaners for agricultural motors are described and discussed and the details of some are diagrammatically illustrated to indicate the principles of their operation. Graphic test data are included.

It is concluded that an air cleaner must be accessible and at the same time easily adapted to the construction of the motor. The best results have been obtained with metal filters with or without oil membranes.

THE USE OF THE AIR LIFT, E. Cunningham. [Domestic Engineering, Chicago, 101 (1922, No. 9, pp. 371-374, figs. 4.] General information is given regarding air lift pumps, together with tabular data showing the economical capacity of discharge pipe in gallons per minute under different conditions of lifts and submergences.

VIABILITY OF THE COLON-TYPHOID GROUP IN CARBONATED WATER AND CARBONATED BEVERAGES, S. A. Koser and W. W. Skinner. [Journal of Bacteriology, Baltimore, 7 (1922), No. 1, pp. 111-121.] Studies conducted by the U. S. Department of Agriculture are reported which showed that carbonation of water exerted a distinctly harmful effect on the members of the colon-typhoid group, and their period of viability was much shorter in carbonated water than in plain tap water. The destructive effect of the carbon dioxid was especially marked at room temperature and less so at one degree Centigrade.

It was found that in a non-acid beverage the organisms may persist for a slightly longer period than in carbonated water. In beverages containing 0.094 per cent or more of citric or lactic acids the death rate was very rapid and was apparently due to the effect of these acids, irrespective of the carbon dioxid. *Bacterium typhosum* and *B. paratyphosum* B were more readily destroyed by carbon dioxid than B. *Coli*. The spore forms of *B. mesentericus* and of *Costridium sporogenes* were found to be quite resistant to carbonation, surviving one month at room temperature with no apparent diminution in numbers.

THE DESTRUCTION OF TUBERCLE BACILLI IN SEWAGE *by* CHLORIN, J. M. Conroy, B. B. Conroy and A. T. Laird. [American Review Tuberculosis, Baltimore, 6 (1922), No. 1, pp. 63-68.] Studies of the effluent from an Imhoff sewage tank receiving the sewage from a tuberculosis sanitorium to determine the frequency with which tubercle bacilli are present in the effluent and the practicability of destroying them with chlorine are reported.

Samples of the effluent taken as it came from the Imhoff tank were found nearly always to contain living tubercle bacilli. The use of a chlorin machine was found to be a practical means of ridding such sewage of tubercle bacilli. It is concluded that two machines should be used to insure continuous disinfection. Preliminary treatment of the sewage is considered to be necessary to reduce it to a liquid form and to prevent the floating of solid particles containing tubercle bacilli in water courses.

SOME GENERALIZATIONS ON THE INFLUENCE OF SUBSTANCES ON CEMENT AND CONCRETE, J. C. Witt. [Philippine Journal of Science, 21 (1922), No. 4, pp. 365-371.] In a second contribution to the subject studies on the effect of eleven salts on the setting time and tensile strength of four different cements are reported. The cements were used in 1:3 standard Ottawa sand briquettes which were stored in the water and broken at the end of 7, 28, and 180 days, one year, and five years. Each test was made in triplicate comprising 2700 tests. All four cements when gauged with water alone showed a decrease in tensile strength between the one and five year periods. The general effect of the various salts was to lower the tensile strength, usually less than fifty pounds. In some cases there was an increase in tensile strength, and the results are not sufficiently regular to permit any definite conclusions as to the relative effects of the different ions present. A comparison of the chemical analysis of the four cements offered no clue as to why one of the cements suffered the greatest loss in strength.

The results are taken to indicate that in general, in the case of concrete at least, ordinary inorganic substances are less likely to affect the strength of cement when they are used in the mixing water than when present in water to which hardened concrete is exposed.

RESISTANCE TO THE TRANSLATION OF MOTOR VEHICLES, T. R. Agg. [Iowa Engineering Experiment Station Bulletin, Ames, 64 (1922). pp. 32, figs. 18.] This progress report covers the methods and results of an investigation begun in 1919 on the subject of road and vehicle resistance, and deals in part with comparative studies of known methods of measuring so-called tractive resistance.

The space-time recorder has been found to offer a dependable and practical method of measuring resistance to translation, and one which is particularly useful in detecting small differences therein. The results indicate that the term "tractive resistance" should be discarded and that the resistances to translation be indicated by rolling, air, transmission system, and engine resistances.

It has been found that the rolling resistance is probably less than 25 pounds per ton of weight of the vehicle for good paved surfaces and good tires, but for low-grade surfaces it may reach 100 pounds per ton. The results to date are taken to indicate that rolling resistance is about half of the total resistance to translation when a motor vehicle with good tires is operated on hard, smooth road surfaces and that the resistance due to impact is very small on such surfaces. It is considered to be equally apparent that resistance due to impact may become a significant factor if the road surface is finished poorly or becomes rough through inadequate maintenance, and that also a high toll in fuel bills is exacted by low grade surfaces. The results of a few fuel consumption tests of a comparative nature are also included.

It is stated that this study is to be continued in cooperation with the Bureau of Public Roads of the U. S. Department of Agriculture.

CEMENTS, LIMES, AND PLASTERS: THEIR MATERIALS, MANUFACTURE, AND PROPERTIES, E. C. Eckel. (New York: John Wiley & Sons, Inc.: London: Chapman & Hall, Ltd., 1922, 2, ed., rev., pp. XXXI-655, pls. 5, figs. 153.) This is the second revised edition of this book which deals with the composition, manufacture, and properties of cements, limes, and plasters.

LUMBER MANUFACTURE IN THE DOUGLAS FIR REGION, H. B. Oakleaf. (Chicago; Commercial Journal Company, Inc., 1922, pp. XII-182, figs. 54.) The purpose of this book is to present data on the methods and cost of constructing and operating plants for the manufacture of lumber from Douglas fir in the region west of the Cascade Mountains in Oregon and Washington. A special effort has been made to include information of value to mill architects and machinery manufacturers. Sections are included on general character of Douglas fir mills, site selection, sawmill, plant and machinery, headsaws, cant lowering devices, edgers, slashers, trimmers, sawmill rolls and conveyors, roller band and gang resaws, cost of sawing, moving lumber within the plant, dry kilns, air seasoning and storage, planing mill, shipping, power, refuse burners, machines and blacksmith shops, fire protection, taxes, insurance, depreciation, working capital, log prices, grades, and yields, fir lumber products, and weight of fir lumber products.

THE EFFECT OF SULPHUR COMPOUNDS ON CEMENT, J. C. Witt. [Philippine Journal of Science, Manila, 21 1922), No. 4, pp. 357-360.] The results of a five-year study of the effect of sulphur compounds on the strength of cement are reported.

These show that concentrations of sodium sulphid not exceeding one gram of sulphur per liter do not affect seriously the tensile strength of cement, and in most cases the strength is increased. With higher concentrations the strength is lowered in every case. The maximum loss in strength was found to be thirty-two per cent with neat cement and thirty-seven per cent with cement mortar. In general the percentage loss in tensile strength of the neat cement mixtures due to the highest concentration of sulphid varied with the iron content of the cement. For a three-year period the presence of as much as five per cent of sulphuric anhydrid did not cause any serious loss in strength and in some instances there was an increase.

STEAM ENGINE PRINCIPLES AND PRACTICE, T. Croft. (New York and London; McGraw-Hill Book Company, Inc., 1922, pp. XIII-513, figs. 548.) This book is a compilation of practical information concerning steam engines for the use of operating engineers or plant superintendents. It contains sections on function and principle of the steam engine; steam engine mechanisms and nomenclature; steam engine indicators and indicator practice; slide valves and their setting; Corliss and poppet valves and their setting; fly-ball steam engines governors, principles, and adjustment; shaft steam engine governors, principles, and adjustment; compound and multi-expansion engines; condensing and non-condensing operation; steam engine efficiencies and how to increase them; steam engines of modern types; steam engine testing; reciprocating engine management, operation, and repair; use of superheated steam in engines; selecting an engine; and steam engine lubrication.

MECHANICAL TESTING, R. G. Batson and J. H. Hyde. (New York: E. P. Dutton & Company, 1922, Vol. 1, pp. XIII-413, pls. 47, figs. 205.) This is the first volume of this work which is a number of the so-called directly-useful technical series, founded by W. J. Lineham. Its purpose is to place before technical engineers, manufacturers, and students the conditions governing modern testing, together with particulars of standard testing plants and their limitations, and such information as will enable the results obtained to be appraised at their true values. Chapters are included on load, strain, stress, and elasticity; properties of materials; testing machines; testing machine grips and shackles and the calibration of testing machines; elongation and contraction of area in the tensile test; procedure in ordinary commercial testing; mechanical tests of hard drawn wire; testing cast iron; influence of shape and time on the properties of materials; measuring instruments for the determination of the elastic constants of materials; autographic recording apparatus; determination of the elastic constants; experiments on the repetition of stresses; resistance of materials to combine stresses; rapid methods of determining fatigue ranges; alternating bending tests beyond the yield point; hardness and abrasion tests; impact and notched bar testing; effect of temperature on the mechanical properties of materials; testing of timber; testing of stone, brick, and concrete; testing road materials; and limes and cement.

PRACTICAL REFRIGERATING ENGINEERS POCKETBOOK, J. E. Starr. [Chicago: Nickerson & Collins Company, 1922, pp.192.] This is an elementary treatise on the subject of refrigeration, supplemented with numerous tables of data on the design, construction, and operation of mechanical refrigerating systems. It contains special chapters on the refrigeration cycle, types of apparatus, the absorption system, compressed air machines, miscellaneous refrigerating and ice-making machines, the brine cooler, cold storage, ice making, insulation, and piping.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1922. [New York: American Society of Heating and Ventilating Engineers, 1922, vol. 1, pp. 360, figs. 78.] This handbook contains reference data useful in the design and construction of heating and ventilating installations, a catalog and reference section comprising essential facts, data, and applications of manufacturer's equipment an engineering and equipment section, an index to modern equipment, and a directory of consulting engineers.

PLUMBERS' HANDBOOK, S. E. Dibble. (New York and London: McGraw-Hill Book Company, 1922 pp. IX-629, figs. 316.) This handbook is intended as a permanent aid to plumbers, engineers, architects, and builders, and presents information designed to perfect plumbing installations. It contains sections on heat, pumps, oxyacetylene welding, general plumbing, fittings, pipe standards and pipe dies, vitrified clay sewer pipe, gas fitting, plumbing fixtures, metallurgy and chemistry, sheet metal work, heating, mathematics, codes, glossary of plumbing terms, and business methods.

DRAFT INVESTIGATIONS OF FARM MACHINERY AT THE NEBRASKA STATION. [Nebraska Station Report 1922, pp. 23, 24.] The results of a large number of plow tests made under varying depths and speeds are said to vary widely in the case of speed draft tests, but are fairly consistent for the depth draft test. The increase in draft due to increase in depth from five to ten inches was approximately twenty-seven per cent of the draft at five inches. Tests to determine the

draft of a disk harrow for different angles of the disk section and the effect of weight on the draft showed that the increase in draft due to angling the sections fully was about 175 per cent of the draft at no angle. The increase in draft due to weighting the disk with a weight of one hundred and eighty pounds was sixty per cent of the no-weight draft.

POTATO DIGGER TESTS. [Implement and Machinery Review, London, 48 (1922), No. 570, pp. 748-752.] Comparative studies under service conditions of a number of different types of potato digger are reported, the purpose being to establish the requirements of a successful potato digger and the relative efficiencies of different types of machines.

A preliminary study of the operation of potato lifters indicated that a successful machine must bring the potatoes well to the surface, leave them well exposed and undamaged, and the draft of the machine must be comparatively light.

The rotary or spinner type of machine gave in general the best results. It is concluded that the general principle of the rotary machine is sound but that further research is necessary into the problems of speed, angle of tine, projecting load, and the resultant effect on the potatoes as well as the ease of digging. When the ten machines were arranged in order of merit according to costs, all of the seven rotary types were included in the first seven, while when arranged in the order of merit according to mechanical efficiency, the first six were of the rotary type.

It was found that the advantages of a low speed gear and an angle of time or 45 degrees in a rotary machine were reflected in the smaller proportion of damaged potatoes and the small number left in the ground. The use of a properly adjusted screen was also beneficial. It is emphasized that the lowest quantity of damaged potatoes was caused by a sharp initial curve in the tines. The fastest moving machines threw the potatoes the farthest. The drawbar load of a rotary machine was affected by the weight of the machine, the line of draft, depth and pitch of share, and the power absorbed in the transmission gearing. The number of tines did not affect the draft to any appreciable extent. With the elevator types of machine the drawbar load was affected by the line of draft, the depth and pitch of the share, and the transmission.

FARM LIGHT AND POWER YEARBOOK, 1922. [New York: Farm Light and Power Publishing Company, Inc., 1922, pp. 338, figs. 180.] This is a directory of manufacturers and wholesalers of farm electric light and power apparatus and a manual of information on the operation and maintenance of electric generators and motors, gas and oil engines, storage batteries, wiring for light and power, accessories, appliances, etc.

FACTORS GOVERNING THE SELECTION AND PROTECTION OF SOURCES OF WATER SUPPLY, J. K. Hoskins. [Public Health Reports (U. S.) Sup. 39 (1921), pp. 20.] Practical information on the subject is presented in this publication. It is stated that determination of the nature and extent of use of a proposed water supply will indicate the inadvisability of selecting certain inadequate or unsuitable sources. Such determinations will also make evident the necessity for accurate knowledge concerning the quantity and quality of water to be expected from various sources. The possibility of pollution of the source is also a factor to be considered carefully, as well as the natural safeguards that exist or can be inaugurated that tend to counteract such pollution. Finally, the relative cost of supplies developed from various sources, carefully balanced against their advantage, will determine largely the source to be chosen. This factor may outweigh many other considerations and indicate the advisability of artificial purification rather than the selection of an uncontaminated source.

THE USE OF ALCOHOL AS A FUEL FOR MOTOR CARS USING INTERNAL-COMBUSTION ENGINES, J. G. Rose. [South African Journal of Industries, Pretoria, 5 (1922), No. 7, pp. 307-312.] This is a discussion of the use of alcohol as a fuel for internal-combustion engines, with particular reference to South African conditions. Special attention is paid to the economic phase of the subject occasioned by the necessity for denaturing. It is stated that the heavy cost of denaturants is not warranted by the results they achieve and that frequently such denaturants as methyl alcohol have a very bad effect on motors, especially if they are impure. It is concluded that the policy of collecting revenue from the sale of alcoholic liquors by means of an excise, with the resultant use of denaturants, constitutes a real impediment to the production of a cheap motor fuel.

THE CHEMICAL CONTROL OF GASEOUS DETONATION WITH PARTICULAR REFERENCE TO THE INTERNAL-COMBUSTION ENGINE, T. Midgley, Jr. and T. A. Boyd. [Journal of Industrial and Engineering Chemistry, Washington, D. C. 14 (1922), No. 10, pp. 894-898, fig. 1.] This is an analysis of the bearing of gaseous detonation on the operation of internal-combustion engines and a progress report of experiments, the purpose of which is to control such detonation by chemical means.

It has been found that detonation in internal-combustion engines can be either suppressed or induced by the presence of very small amounts of certain materials in the combustible mixture. These substances may be dissolved or suspended in the fuel, or they may be admitted to the combustion chamber in some other way. It is stated that the action of practically every type of compound that should affect detonation has been tried, and a large number have been found to possess the property of affecting combustion in such a way as either to suppress or induce detonation.

The compounds which possess this property of affecting the reaction velocity of combustion to a marked degree are chiefly derivatives of about fifteen elements. Oxygen and the halogens in the elemental form exert a marked effect on combustion. Iodine is an anti-knock material and the other elements induced detonation to different degrees. A great many nitrogen compounds are effective anti-knock materials, probably the best of which are the aromatic amins. Certain compounds of selenium, tellurium, tin and lead are remarkably effective for the suppression of knock, while some compounds of arsenic, antimony, and phosphorous have a marked but lesser effect for preventing knock. The effects of anti-knock materials on detonating combustion are described.

THE PRESERVATION OF DECAYING WOOD ROOFS. W. S. Brown. [Mechanical Engineering (New York), 44 (1922), No. 11, pp. 709-712, figs. 6.] This is an analysis of the general theory of wood decay, cause of decaying wood roofs, and methods employed in preserving wood roofs.

It is stated that in wood-roof decay the so-called damp rot group of fungi are to be considered. Decay in roofs is usually greatest in planks and beams at bearings because, due to the additional insulating properties of the supporting members, the locus of moisture condensation tips. Tops of roof rafters and girders rot first, and, other conditions being equal, decay is more active in the vicinity of ventilators and cold conductor pipes.

In the case of existing roofs the treatment must of necessity be ameliorative rather than preventative or curative. The treatment consists in removing the water supply from the fungus causing wood decay by preventing condensation as far as is practicable. It has been found that condensation is decreased by insulating the outer roof surface, the extent of inhibition depending on the amount of insulation. It has been found that top insulation has the effect of moving the plane or locus of condensation for any given set of atmospheric conditions nearer the outer surface of the plank than before, and in mild weather of eliminating it entirely.

Economic considerations in prolonging the useful life of repaired roofs are also presented.

COLORIMETRIC TEST FOR CONCRETE SAND STUDIED, C. E. Proudley, [Engineering News-Record, 89 (1922), No. 15, pp. 617, 618.] In a contribution from the U. S. Department of Agriculture results of studies of the standard test for organic impurities in one hundred and sixty normally graded sands are reported.

The data on the apparent effect of organic matter on the strength ratio at seven days showed that of the total number of sands considered there were only thirty-two which failed to show one hundred per cent strength ratio. Fifty-six per cent of those below one hundred per cent strength ratio were found to contain objectionable minerals, while less than half that number were found among those of higher strength ratio. Eighty-three of the sands showed satisfactory color and the other seventy-seven were subject to doubt, but of the eighty-three good sands eight were found to be low in strength, and of the seventy-seven doubtful sands fifty-three were really satisfactory. These results were taken to indicate that this test is much more likely to cause the rejection of a satisfactory sand than the recommendation of an unsuitable sand.

Studies of the apparent effect of organic matter on the strength ratio from seven to twenty-eight days showed that more of the sands decreased in strength ratio than remained constant. This is taken to indicate that a certain amount of consideration for the possible reduction in strength ratio at twenty-eight days should be given. It is emphasized, however, that the peculiarities of the district from which a sand comes should not be overlooked. "Large areas are sometimes supplied with materials which, if use depended on the indications of organic matter, would never build concrete roads. As has been pointed out, there are many sands of good quality showing a dark colorimetric test. On the other hand, there are regions in which a testing engineer can safely prophesy the tensile strength ratio by reference to mechanical analysis and color. Still others never find organic matter in their sand even though they experience the usual difficulties with the strength. Thus, the dependability of the test is best judged by those who use it according to the circumstances involved."

SOILS, IRRIGATION, AND DRAINAGE INVESTIGATIONS. [California Station Report, 1921, pp. 19, 20, 21, 22, 23.] A number of studies are reported, among these the progress of the ground water studies at Kearney Park, is set forth briefly.

Field studies by S. H. Beckett and F. J. Veihmeyer are said to show that after an irrigation a uniform soil has a very even distribution of water throughout the wetted portion. Any increase in the quantity of water increases the depth of penetration but not the amount held in any part of the wetted zone. Laboratory experiments by C. F. Shaw, conducted under controlled conditions, using a long column of soil, seemed to bear out this observation, provided the applied water was not greater than the amount required to wet the full depth of soil used. Repeated tests, using different depths of irrigation water, showed that the amount held in any given portion of the soil is relatively uniform regardless of the amount applied, but that if there is any obstruction to the free downward percolation of the water, the quantity of water increases materially throughout the entire zone above that obstruction.

Field studies by Beckett and Veihmeyer on the efficiency of soil mulches in reducing the loss of water by evaporation from the surface, when the initial amount of water present is not above the normal water-holding capacity, seemed to show that under such conditions a mulch had a very limited effect in saving water. Repeated laboratory tests by Shaw, B. F. Monroe, and R. E. Storie to determine the losses by evaporation after the application of a limited irrigation showed that with undisturbed soils the upper three inches dried out very quickly, but that after this water had been lost by evaporation further losses were very small. The experiments seemed to bear out the field observations that in irrigated soils under the conditions mentioned mulches will have little effect in conserving the moisture supply.

Investigations by Shaw on the relative distribution of water lifted into the soil by capillary forces showed that there is a critical moisture point at from four to six inches above the bottom of the tube, where a larger quantity of water is held than at any other point in the soil column. Comparisons of the distribution of water by capillary rise and by irrigation, using the same amount of water on the same depth and quantity of soil, showed that while the distribution after irrigation is relatively uniform throughout the column, the distribution after capillary rise is less uniform. The quantity increases from the bottom of the tube to a height of from six to eight inches, then decreases until the dry soil or the surface of the soil in the tube is reached. Where large quantities of water were used and the soils were free to hold or to lift as much as they could, it was observed that a much larger total amount of water was held in a given depth of soil through capillary rise activities than by the water-holding action after irrigation.

In an experiment to determine the effect of varying quantities of organic matter on the water-holding capacity of the soil as measured by the moisture equivalent, Monroe found that there was a direct relation of considerable moment between the amount of organic matter present and the moisture equivalent. There did not seem to be any marked relation between the latter and the condition of the organic matter, whether in a raw state or in a state of thorough decay. It was further observed that the presence of clay in the soil had a much larger unit influence on the water-holding capacity than did the presence of organic matter.

In studies of the development of an improved soil tube, Veihmeyer found that soil samples taken with a tube give a better measure of the maximum moisture content than samples taken with an auger. A type of soil tube has been evolved which takes a perfect core with no compacting.

ALKALI INVESTIGATIONS. [California Station Report, 1921, pp. 24-26.] In studies on the reclamation of alkali land by W. P. Kelley it has been found that the application of gypsum resulted in a substantial reduction of the black alkali in the first foot of soil and a small reduction in the second foot. Below this level the gypsum had very little effect. The white alkali salts were largely leached out both on the gypsum treated and check plats. The results are taken to indicate that it is not practicable to remove black alkali from this soil by leaching alone.

Studies by A. B. Cummins on the formation of black alkali in soils have shown that black alkali may be formed (1) as the result of leaching, where the soil has been previously impregnated with sodium chlorid or sodium sulphate, (2) by the action of sodium chlorid or sodium sulphate on calcium carbonate, and (3) by the action of meteoric water on the granites from which the soils have been derived.

Studies of the effects on plants caused by high concentrations of salts and high alkalinity in soil have shown that concentrations of hydroxyl ion in excess of pH 8.2 to 8.5 are very toxic to many plants. In applying these data to soils it has been found that high pH values of soil suspensions, although grounds for suspicion, do not always imply toxicity for the reason that the alkalinity of the soil solution in certain soil systems may be markedly decreased by the carbon dioxid present. Experiments on the chemical mechanism of injury to plants by salts, alkalinity, and acidity have shown that when equal osmotic concentrations of sodium chlorid, sodium sulphate, and calcium chlorid are considered, the last salt is the most toxic to barley. High concentrations of calcium chlorid may produce marked effects on the reaction and buffer system of the plant.

Studies by C. B. Lipman and A. R. Davis on the resistance of wheat to common salt in culture solution have shown that this resistance seems to be extremely high under the conditions of the experiments. Stimulation to the growth of the wheat plant was noted in concentrations up to 6000 parts per million of common salt in the solution. A temporary depression occurred at the lower concentrations both at the roots and tops at certain stages in the growth of the plant.

Experiments by P. L. Hibbard have shown that a small amount of sodium alkalinity in soils may be so largely neutralized by gypsum that the remaining alkalinity does not seriously hinder production of good crops, but if the original alkalinity is high or if the soil contains a large amount of sodium salts, gypsum alone is ineffective and leaching also is required. Leaching may be done in thin layers two inches in thickness or in columns five feet in depth, the latter practice requiring a much longer time for complete leaching than the former. The results of experiments on the neutralizing effect of sulphur seem to offer a means whereby this long period of leaching and subsequent long time for restoration of fertility may be very materially shortened. It was found that rapidly decaying organic matter such as manure or green manure reduces toxic alkalinity in proportion to the rapidity of formation of carbon dioxid.

ECONOMY OF TRACTOR-DRAWN BINDERS AND MECHANICAL STOOKING. [Implement and Machinery Review, London, 48 (1922), No. 569, pp. 640, 641, figs. 3.] Comparative studies of the economics of harvesting oats with a horse-drawn binder, a tractor-drawn binder, a tractor and two binders, and a tractor-drawn combination binder and shocker are reported.

Mechanical binding was found to effect a saving of 75 per cent in hand labor over hand binding. The combined operations of binding and shocking gave results considerably superior to the two binders plus hand shocking. The mechanically made shocks consisted of six, eight, or ten sheaves as desired and were delivered safely and well out of the shocker cradle.

The mechanical shocker is attached to the ordinary binder by two tubular stays, the more important one passing from about the center of the bull wheel and supporting a chain and sprocket wheel which transmit the drive to the shocker. The latter runs alongside but a little in the rear of the binder, so that its fore-carriage on which rests the sheaf-delivery fork is exactly where the sheaves are delivered from the binder. As the first sheaf is released by the binder it is held by an arrangement until a second one arrives, and thereafter a kicker device delivers a pair of sheaves simultaneously directly onto the fork. The latter takes them over to the cradle where they lie lengthwise, with the straw end pointing rearward. Other sheaves come along until the requisite number is received; a special tying mechanism passes binder twine around the whole, pulls it tight and ties it, and then the shock is discharged butts downward.

DURABILITY OF CEMENT DRAIN TILE AND CONCRETE IN ALKALI SOILS: THIRD PROGRESS REPORT, (1919-20), G. M. Williams et al. [U. S. Department of Commerce, Bureau of Standards Technologic Paper 214 (1922), pp. 463-494, pls. 4, figs. 1.] In the third progress report of this cooperative investigation (E.S.R., 39, p. 86), the results of inspection in 1919 and 1920 of experimental drain tile and concrete block installations at eight alkali-bearing projects in the west are presented.

These indicate again that materials of good quality and proper workmanship are of great importance in the production of concrete which is to be exposed to alkali soils and waters. The action noted on surfaces of concrete blocks of the best quality after one year of exposure in sulphate waters has in most cases been progressive, depending upon the conditions of exposure. The extent and rapidity of disintegration in sulphate waters were found to depend on the concentration of the salts in the waters to which the concrete was exposed. In blocks containing reinforcing rods disintegration appeared to be aided and accelerated in some cases by corrosion of embedded steel and consequent cracking of the concrete.

Disintegration was found to be brought about only by those salts which are in solution. For the same concentration of soluble salts and for the same aggregates, the resistance of mass concrete to alkali action appeared to vary with the cement content or richness of mixture.

The conclusion is drawn that alkali salts are not uniformly distributed throughout the soil or large bodies of seepage waters, and it will be difficult to determine in advance the concentrations to which a structure may later be exposed. A systematic scheme for sampling soils should furnish information as to the quantities and types of salts available for solution, while analysis of seepage waters should indicate the concentrations present at the time of sampling.

It is concluded that seepage waters and alkaline soil conditions may be encountered which will disintegrate concrete of the best quality.

In the investigations of cement drain tile it was found that the use of concrete tile in soils containing alkali salts of the sulphate type in considerable quantities is hazardous, since the best quality of drain tile were disintegrated during an exposure of less than six years. Porous or permeable tile, due to the use of lime mixtures or relatively dry consistencies, were disintegrated in sulphate waters of relatively low concentrations. Dense tile of the best quality exposed to sulphate waters disintegrated under certain conditions, depending on the concentration of the salts in the seepage waters and the alkali and moisture conditions in the soil immediately surrounding the tile.

It was found that disintegration may be manifested in sulphate waters by physical disruption caused by expansion resulting from the crystallization of the salts in the pores, but that it is primarily due to chemical action between the salts in solution and the constituents of the cement. In the case of dense tile of low permeability exposed to sulphate waters, disintegration may occur at or just inside of the surface skin and progress into the wall of the tile. A thin outer skin of apparently unaffected concrete was apparent in the case of disintegration of the best quality of tile. The results indicate that this carbonized coating, while immune to attack by salts in solution, is not waterproof, and alkali may pass through it into the mass. With a concrete or mortar of a given quality the disintegrating effect of sulphate waters seemed to vary with the concentration of the solution.

Tile made by the process commonly used, which allows the removal of forms immediately after molding, were found to be more susceptible to disintegration where exposed to sulphate soils or waters than tile made of a wetter consistency requiring their retention in the molds for a period of hours. The use of hand-tamped tile of plastic consistency, such that the jacket can be removed immediately after molding, is not recommended in sulphate soils and waters. Tile of plastic consistency, molded in the packer-head type of machine, were more resistant to alkali than the hand-tamped tile, but the best quality of packer-head machine tile was affected by waters of higher salt concentration. Steam cured tile showed no greater resistance to alkali action than tile cured by systematic sprinkling with water. Tile made of sand cement had less resistance to alkali action than tile made of Portland cement of the same proportions. Neither a tar coating nor a cement grout coating was effective in preventing the absorption of alkali water into the walls of the tile. No advantage was found in introducing ferrous sulphate into the cement mixture. The use of this material reduced the crushing strength of the tile.

It is concluded that if cement drain tiles are to be used in soils and waters containing 0.1 per cent or more of salts of the sulphate type, their installation should be preceded by an examination of subsurface alkali conditions and that quality of cement drain tile can be measured best by permeability tests. With other conditions equal, tile of the lowest permeability will be the most durable. Little definite relation was found between permeability and the related factors of porosity, absorption, and density.

An appendix dealing with absorption tests of tile and with the presence and distribution of salts in the soil and their action on cement and concrete is included.

THE INFLUENCE OF IRRIGATION WATER ON THE COMPOSITION OF THE SOIL. J. E. Greaves. [Journal of American Society of Agronomy, 14 (1922), No. 5, pp. 207-212.] This paper summarizes briefly some results which have been obtained on the subject at the Utah Experiment Station during the past ten years. Hundreds of samples of water representing fifty-eight streams, the majority of which are extensively used for irrigation purposes, have been analyzed. These have shown that two acre-feet of water have carried to the soil from 4.4 to 266.6 pounds of potassium, sufficient to produce 370 bushels of corn, 230 bushels of wheat, or 34 tons of sugar beets.

The total phosphorous content of the irrigation waters analyzed varied from traces to 5.47 parts per million, although the great majority contained less than one part per million. The average in two acre-feet from the streams was 3.46 pounds, from wells 3.36 pounds, and from drains 1.82 pounds. Two acre-feet of the water from the richest stream are said to be sufficient in phosphorous content for the production of 175 bushels of corn, 120 bushels of wheat, or 33 tons of sugar beets.

The average quantity of nitrogen in two acre-feet of the irrigation water was found to be 22.8 pounds, while that in the richest water was 132.2 pounds, which is considered to be sufficient to produce 186 bushels of corn, 114 bushels of wheat, or 17 tons of sugar beets.

In addition to its fertilizer constituents, the irrigation water was found to carry varying quantities of soluble salts which may at times be sufficiently concentrated to become a menace.

It is concluded that the intelligent use of irrigation water requires a knowledge of the chemical, physical, and biological properties of the soil, together with a knowledge of the composition of the water and its influence upon the different changes in the soil.

Drainage and Supplemental Irrigation for the Willamette Valley in Oregon

(Continued from page 127)

plant food, and affords solution and conveyance into the plant. Providing this moisture during the best growing weather has made it possible to produce dry matter at a lower requirement per pound than has been realized with the dry-farmed plats.

Here is opportunity for development of some irrigation projects. Several thousand acres of good free-working soil in the first and second bottoms along the Willamette north of Eugene can be irrigated and will be suitable for small fruit, truck, and very intensive forms of agriculture when reclaimed and improved. There are also other areas of free land near the Santiam River in Marion County and along Dairy Creek in Washington County; also some lands of less sandy texture but suitable for intensive crops with supplemental irrigation. Perhaps the largest field for development here is in connection with the use of small individual

pumping plants, and it is possible by proper irrigation to double the yield of about one-sixth of the soils in the valley, being the naturally drained free working soil areas that are not too heavy on the one hand or too sievelike on the other. The enterprise is delayed partly due to lack of knowledge of the value of irrigation or skill in its use. However, there are here opportunities for irrigation farming in a region where there is a long-growing season, good transportation facilities at hand, and in a healthful settled section free from those hardships of pioneering which must be faced in a raw, arid section.

A. S. A. E. and Related Activities

Report of Nominating Committee

THE Nominating Committee of the American Society of Agricultural Engineers has placed in nomination the following names as candidates for election to the several offices as indicated, to take office January 1, 1924:

For president, S. H. McCrory
For first vice-president, L. J. Fletcher
For second vice-president, E. R. Jones
For treasurer, Raymond Olney
For member of council (for three years), F. W. Ives
For nominating committee, L. J. Strahan, Chairman; J. B. Kelley and I. W. Dickerson

Thirty days from the publication of this report, or from the time this issue of AGRICULTURAL ENGINEERING reaches members, the Secretary will prepare and mail secret letter ballot to all voting members. This intervening period is to allow special nominating committees to make additional nominations for the offices above.

QUALIFICATIONS OF CANDIDATES

SAMUEL HENRY MCCRORY, candidate for the office of President, is chief of the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, and since the Society joined the Federated American Engineering Societies as a charter member, has acted as representative of this Society on American Engineering Council, the executive body of the Federation and has just recently been appointed by the Council to serve in the same capacity for the year beginning January 1, 1924. Mr. McCrory was elected to membership in the Society in 1919 and has served in important capacities since that time, rendering a valuable service to the Society. He is a graduate of the University of Iowa and since 1907 has been engaged in drainage work with the U. S. Department of Agriculture.

LEONARD J. FLETCHER, candidate for first vice-president, is associate professor of agricultural engineering and head of the department at the branch college of agriculture of the University of California, Davis. Prof. Fletcher was elected to membership in the Society in 1921 and since that time has been very active in Society activities, particularly in promoting the interests of the Society on the Pacific Coast. He is a graduate in agricultural engineering of Iowa State College. Previous to going to his present position he was connected with the agricultural engineering division of the Washington State College. He succeeded Prof. J. B. Davidson as head of the agricultural engineering division at California in 1916, a position which he has held since that time.

EDWARD R. JONES, candidate for second vice-president, is professor of agricultural engineering and head of the department at the University of Wisconsin. Prof. Jones was elected to membership in the Society in 1914 and has been a very active member since that time, rendering valuable service particularly in connection with the Society's activities in promoting drainage engineering. He is a graduate of the University of Wisconsin and has had charge of the drainage work for the college of agriculture of that institution since 1905.

RAYMOND OLNEY, candidate for reelection to the office of treasurer, has served the Society as secretary since November 1921 and as treasurer since January 1922. In addition he also holds the position of editor of *Power Farming*. Mr. Olney was elected to membership in the Society in 1912 and has been active in Society affairs since that time; he was president of the Society in 1919. Mr. Olney is a graduate of Cornell University in mechanical engineering and of Iowa State College in agricultural engineering. He is also editor and publication manager of AGRICULTURAL ENGINEERING.

FREDERICK WALTER IVES, candidate for member of the Council of the Society to serve three years, is professor of agricultural engineering and head of the department at Ohio State University, and also consulting engineer and architect for the University. Prof. Ives was elected to membership in the Society in 1916 and since that time has rendered valuable service in promoting the various Society activities, particularly along farm buildings and educational lines. He is a graduate of the University of Wisconsin and Ohio State University. He was secretary-treasurer of the Society during 1918 and 1919.

Nominations for the A. S. A. E. College Section

THE report of the Nominating Committee of the College Section includes the following list of candidates from which two members will be elected to serve on the Advisory Committee of the College Section for a period of two years. The election will be by letter ballot, each state having one vote:

J. B. Davidson, Iowa
L. J. Fletcher, California
E. R. Gross, New Jersey
F. W. Knipe, Connecticut
H. H. Musselman, Michigan
H. W. Riley, New York
C. E. Seitz, Virginia
E. A. Stewart, Minnesota
H. B. Walker, Kansas
J. C. Wooley, Missouri

New Members of the Society

MORRIS C. BETTS, architect, division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, Washington, D. C.

THOMAS L. CALLAHAN, experimental engineer, Moline Plow Company, St. Louis Park, Minnesota.

ARTHUR E. JUNGHAUS, mechanical engineer and consultant to vice-president and general manager, Guantanamo Sugar Company, Guantanamo, Cuba.

TRANSFER OF GRADE

ALFRED GLENDENNING, West Dover, Ohio. (From Student to Junior Member.)

JOHN ROBERT SCHOFIELD, 39 E. Norwich Avenue, Columbus, Ohio. (From Student to Junior Member.)

VILAS D. YOUNG, Galesville, Wisconsin. (From Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

Anton E. Jensen, instructor in farm mechanics, Oregon Agricultural College, Corvallis, Oregon.

Robert E. Kreitler, R. F. D. No. 7, Warren, Ohio. (Transfer from Student to Junior Member.)

William Hunter Strong, agent Child Welfare Commission of North Carolina, Raleigh, North Carolina. (Transfer from Student to Junior Member.)

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks, and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduating from Iowa State College June 10, 1923, would like position with some company or individual engaged in drainage or irrigation work. Five years' practical farm experience. MA-118.

GRADUATE AGRICULTURAL ENGINEER, now employed by tractor company, wishes position teaching agricultural engineering work. Will be available in summer or to start next fall. MA-115.

AGRICULTURAL ENGINEER, graduating from University of Illinois at end of present semester (available March 1, 1923) would like position in service department or experimental department of company manufacturing tractors or farm machinery. Three years' practical farm experience in West and one year in Illinois. Age 27. Unmarried. MA-116

DEVELOPMENT AND RESEARCH ENGINEER, technical graduate, inventive ability, practical, experienced in the development, design, manufacture, and distribution of farm machinery. Can carry through from the embryo idea, through development stages, production in manufacturing, and marketing. Age 29. Married. Excellent character. Available immediately. MA-117.

AGRICULTURAL ENGINEER wants position about November 1 in teaching, sales, or experimental work along agricultural engineering lines. Have B. S. A. degree University of Minnesota; Minnesota gas and steam engineer certificate; took Dunwoody general machine shop course and a business college course. Experiences are army officer, instructor in three universities in agricultural engineering, owner of motorized farm, and owner of Ford garage and power and farm machinery business at present. At present studying Alexander Hamilton course. Member American Society of Agricultural Engineers, and a Mason. Would consider foreign service. MA-119.

Positions Open

DRAFTSMAN who has had experience in designing and manufacturing threshing machinery with reliable, well-established farm-machinery manufacturer in central Pennsylvania. PO-1.

STUDENT FELLOW IN AGRICULTURAL ENGINEERING. There will be an opening beginning September, 1923, for a student fellow in agricultural engineering at the Virginia Polytechnic Institute. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-4.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering of the Virginia Polytechnic Institute has an opening for an instructor to handle farm surveying, farm buildings, farm concrete, and rural architecture. He will also devote part time to extension work. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-5.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering, Macdonald College, will have on opening beginning September 1 for an instructor in farm machinery, concrete work, farm sanitation, carpentry and drainage. Write L. G. Heimpel, Department of Agricultural Engineering, Macdonald College, P. Que., Canada. PO-6.

INSTRUCTOR IN FARM SHOP WORK and to carry on outside investigation along this line wanted by an agricultural college in the South. Salary $2250 to $2500. Ranking will be assistant or associate professor according to qualifications. PO-7.

EXTENSION AGRICULTURAL ENGINEER wanted immediately. Man with experience required. Salary according to training and experience. Write University of Nebraska, Lincoln, giving qualifications and references. Also state minimum salary. PO-8.

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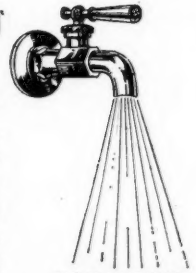

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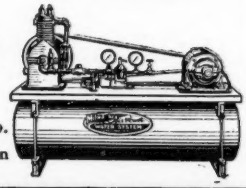

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